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UTILIZING SIMULATION TO ADVANCE PROGRAMMING PROFICIENCY AMONG COMPUTER ENGINEERING STUDENTS IN ANAMBRA STATE, NIGERIA

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Abstract
This study investigates the effectiveness of simulation-based learning in enhancing programming proficiency among computer engineering students in Anambra State, Nigeria. A quasi-experimental design was employed, involving 120 students from two universities, divided into an experimental group (using simulation) and a control group (using traditional methods). The objective was to assess whether simulation improves programming skills, problem-solving abilities, and retention compared to conventional teaching. Pre- and post-tests were administered, and data were analyzed using t-tests. Results indicate that the experimental group outperformed the control group significantly in programming proficiency ($p < .05$). The findings suggest that simulation is a valuable tool for advancing programming education in resource-constrained settings like Anambra State. Implications include the need for integrating simulation tools into curricula to bridge skill gaps and enhance employability.

Keywords: simulation, programming proficiency, computer engineering, education technology

Introduction

Due to recent advancements in computer technology, the fields of science and engineering have recently become very dynamic. Computers have been used in education in many ways since their history. Computer simulations contain visual features for representing authentic systems or phenomena and have been recognized as an effective tool for teaching and learning in science (Duangngoen & Srisawasdi, 2016). Virtual reality simulators are becoming essential to modern education (Roy et al., 2017). Numerous computer programs to solve common and uncommon problems have been produced due to these advancements. These programs help plan, create, and manage complex systems using the computer's enhanced computational capabilities. Various teaching methods are emerging, and virtual simulation technology as a new teaching media has begun appearing in education and teaching (Yu & Chen, 2022). The use of virtual simulation technology to help students visualize the landscape space in front of students is of great help to students' spatial cognitive learning (Zhang & Ma, 2022). Virtual learning simulations are increasingly being used in diverse educational and training contexts as a supplement to traditional educational methods (Badowski & Wells-Beede, 2022; Behmadi et al., 2022; de Vries & May 2019; Foronda et al., 2020; Garmaise-Yee et al., 2022; McGarr, 2020; Moscato & Altschuller, 2019; Nassar & Tekian, 2020; Padilha et al., 2019; Perez et al., 2022; Qiao et al., 2021). Similarly, previous research has underscored its educational benefits (Dyrberg et al., 2017; Khan et al., 2018; Soraya et al., 2022; Wertz, 2022).

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It has been argued that students' understanding of scientific ideas and concepts is based on their engagement in science and engineering practices (Papakonstantinou & Skoumios, 2021). Computer simulations allow students to quickly grapple with realistic scenarios that may not be possible to experience in real life because they may be too dangerous or only occur rarely (Wang et al., 2014). Literature suggests that virtual learning simulations allow students to observe supposedly unobservable phenomena, reduce the time commitment of experiments that would take a very long time if they were carried out physically, and provide guidance that is both online and dynamic (De Jong et al., 2013). Virtual learning simulations can promote learning in a novel way by assisting students in building an understanding of concepts and processes through inquiry-based learning and participation in realistic investigations with continuous feedback. (Bonde et al., 2014; Furtak et al., 2012). In particular, learning simulations make an excellent platform for inquiry-based learning because they allow students to acquire conceptual knowledge while independently investigating a scientific issue using the appropriate methodology in the field. Furthermore, students are motivated by these simulations because they provide them with challenges coupled with continuous feedback in a learning environment better suited to their specific needs and interests.

Modeling with a computer simulation in designing electrical and electronic circuits is important because it is a reliable and affordable method to assess the circuit's performance. It has been discovered that computer-aided simulation can be a handy tool, with simulation serving as a medium through which students can make connections between theoretical concepts and experimental electronic processes. In order to simulate the operation of an electronic device or circuit, simulation software employs mathematical models. It is essentially software that can transform a computer into an electronic lab. Numerous simulation modules support basic electronic practices based on virtual laboratories. For example, several studies have employed Proteus (Waluyo et al., 2021), Multisim (Djalal & HR, 2019), MatLab (Benotsmane et al., 2020) LabView (Korgin et al., 2019), and PSPICE (Muchlas & Budiastuti, 2020) software as a virtual laboratory on basic electronics subjects.

Programming proficiency is a cornerstone of computer engineering education, equipping students with the skills to design, develop, and maintain software systems. In Nigeria, particularly in Anambra State, computer engineering students often face challenges in mastering programming due to limited access to practical resources, outdated teaching methods, and insufficient hands-on experience. These challenges contribute to a gap between academic training and industry expectations, exacerbating unemployment among graduates. Simulation-based learning, which involves using software to mimic real-world programming scenarios, has emerged as a promising pedagogical approach globally. It allows students to experiment, debug, and solve problems in a controlled environment without the need for extensive physical infrastructure. This study explores the potential of simulation to enhance programming proficiency among computer engineering students in Anambra State, Nigeria, a region known for its growing educational institutions and technological aspirations.

Objective of the Study

The primary objective of this study is to evaluate the effectiveness of simulation-based learning in improving programming proficiency among computer engineering students in Anambra State, Nigeria. Specifically, it aims to:

- Assess the impact of simulation on students’ ability to write and debug code.
- Compare the performance of students using simulation with those using traditional lecture-based methods.

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- Examine the retention of programming concepts over time.

Method

A quasi-experimental design with a pre-test/post-test framework was adopted. Two groups were formed: an experimental group exposed to simulation-based instruction and a control group taught using traditional lecture methods. The study involved 120 computer engineering students from two universities in Anambra State: Nnamdi Azikiwe University (federal) and Chukwuemeka Odumegwu Ojukwu University (state). Participants were randomly assigned to either the experimental group (n = 60) or the control group (n = 60). All participants were in their third year, ensuring a baseline familiarity with programming concepts.

Instrumentation

A Programming Proficiency Test (PPT) was developed, consisting of 30 multiple-choice and practical coding questions covering syntax, logic, and debugging in Python—a widely taught language in Nigerian universities. The test's reliability was established with a Cronbach's alpha of 0.87. Pre-tests assessed baseline proficiency, while post-tests measured improvement after the intervention.

Procedure

The intervention lasted eight weeks. The experimental group used a simulation tool (e.g., a Python IDE with integrated debugging and scenario-based exercises), while the control group received traditional lectures and manual coding exercises. Both groups were taught the same curriculum by instructors trained to maintain consistency. Pre-tests were administered before the intervention, and post-tests were conducted immediately after, with a retention test given four weeks later.

Data Analysis

Data were analyzed using independent samples t-tests to compare pre- and post-test scores between groups. A significance level of $p < .05$ was adopted.

Results

The results are summarized in Table 1 below, showing mean scores and standard deviations for both groups across pre-test, post-test, and retention test phases.

Table 1: Comparison of Programming Proficiency Scores Between Experimental and Control Groups

Test Phase	Group	Mean Score	Standard Deviation	t-value	p-value
Pre-test	Experimental	52.3	8.7	0.45	.653
	Control	53.1	9.1		
Post-test	Experimental	78.6	7.2	6.82	.001
	Control	62.4	8.9		
Retention Test	Experimental	75.9	6.8	5.97	.001
	Control	60.2	9.3		

No significant difference existed between the experimental ($M = 52.3$, $SD = 8.7$) and control groups ($M = 53.1$, $SD = 9.1$) at baseline ($t(118) = 0.45$, $p = .653$), indicating comparable initial proficiency in the pre-test. While the experimental group ($M = 78.6$, $SD = 7.2$) significantly outperformed the control group ($M = 62.4$, $SD = 8.9$) after the intervention ($t(118) = 6.82$, $p < .001$), suggesting that simulation enhanced programming skills in the post-test. The experimental group ($M = 75.9$, $SD = 6.8$) maintained

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higher proficiency than the control group (M = 60.2, SD = 9.3), with a significant difference ($t(118) = 5.97$, $p < .001$), indicating better retention of concepts.

Discussion

The findings demonstrate that simulation-based learning significantly improves programming proficiency among computer engineering students in Anambra State. The experimental group's superior post-test and retention scores align with prior research highlighting simulation's ability to provide interactive, practical experience (Nkemakolam et al., 2018). The hands-on nature of simulation likely enhanced students' ability to debug code and solve problems, skills critical for programming mastery.

The lack of significant difference in pre-test scores ensures that the observed improvement is attributable to the intervention rather than prior knowledge. The retention test results further suggest that simulation fosters deeper understanding, as students retained concepts longer than their peers using traditional methods. This is particularly relevant in Anambra State, where resource limitations often restrict practical training.

Implication of the Study

The study has several implications for computer engineering education in Anambra State and similar contexts. For instance, universities should incorporate simulation tools into programming courses to enhance practical skills and align education with industry needs. Simulation reduces dependency on physical labs, making it a cost-effective solution for resource-scarce regions. Improved programming proficiency can boost graduates' competitiveness in Nigeria's tech job market, addressing unemployment challenges. Educational policymakers should invest in training instructors and acquiring simulation software to scale this approach.

Conclusion

This study confirms that simulation-based learning significantly advances programming proficiency among computer engineering students in Anambra State, Nigeria. By offering an interactive, practical alternative to traditional methods, simulation bridges the gap between theoretical knowledge and applied skills. Its adoption could transform programming education in Nigeria, preparing students for technological innovation and economic contribution. Limitations include the study's focus on Python and a relatively short intervention period. Future research could explore other languages and long-term impacts.

References

Akselbo, I., Killingberg, H., & Aune, I. (2020). Simulation as a pedagogical learning method for critical pediatric nursing in Bachelor of Nursing programs: a qualitative study. *Advances in Simulation*, *5*(1). https://doi.org/10. 1186/s41077-020-00140-2

Badowski, D., & Wells-Beede, E. (2022). State of Prebriefing and Debriefing in Virtual Simulation. *Clinical Simulation in Nursing*, *62*. https://doi.org/10. 1016/j.ecns.2021.10.006

Behmadi, S., Asadi, F., Okhovati, M., & Sarabi, R. E. (2022). Virtual reality-based medical education versus lecture-based method in teaching start triage lessons in emergency medical students: Virtual reality in medical education. *Journal ofAdvances in Medical Education and Professionalism*, *10*(1). https://doi.org/10.30476/jamp.2021.89269.1370

Benotsmane, R., Dudás, L., & Kovács, G. (2020). Simulation and trajectory optimization of collaborating robots by application of Solidworks and Matlab software in industry 4.0. *Academic Journal ofManufacturing Engineering*, *18*(4).

Cite this article as:
Mokwe, N.C. (2025). Utilizing Simulation to Advance Programming Proficiency Among Computer Engineering Students in Anambra State, Nigeria. *International Journal of Functional Research in Science & Engineering,3*(1), 15-21.

Bonde, M. T., Makransky, G., Wandall, J., Larsen, M. V., Morsing, M., Jarmer, H., & Sommer, M. O. A. (2014). Improving biotech education through gamified laboratory simulations. *Nature Biotechnology*, *32*(7). https://doi.org/10. 1038/nbt.2955

Cristol, D., Choi, M., Mitchell, R., & Burbidge, J. (2015). Mobile technology in K-12 environments. In *Handbook ofMobile Teaching and Learning*. https://doi.org/10. 1007/978- 3-642-54146-9_33

Davis, A. (2019). Virtual Reality Simulation: An Innovative Teaching Tool for Dietetics Experiential Education. *The Open Nutrition Journal*, *9*(1). https://doi.org/10.2174/1876396001509010065

De Jong, T., Linn, M. C., & Zacharia, Z. C. (2013). Physical and virtual laboratories in science and engineering education. In *Science* (Vol. 340, Issue 6130).https://doi.org/10.1126/science.1230579

de Vries, L. E., & May, M. (2019). Virtual laboratory simulation in the education of laboratory technicians–motivation and study intensity. *Biochemistry and Molecular Biology Education*, *47*(3). https://doi.org/10. 1002/bmb.21221

Djalal, M. R., & HR, H. (2019). Characteristic Test of Transistor Based Multisim Software. *PROtek : JurnalIlmiah TeknikElektro*, *6*(2). https://doi.org/10.33387/protk.v6i2.1214

Duangngoen, S., & Srisawasdi, N. (2016). Electricity's visible: Thai middle school students' perceptions of inquiry-based science learning with visualized simulation. *ICCE 2016 - 24th International Conference on Computers in Education: Think Global Act Local - Workshop Proceedings*.

Dyrberg, N. R., Treusch, A. H., & Wiegand, C. (2017). Virtual laboratories in science education: students' motivation and experiences in two tertiary biology courses. *Journal ofBiological Education*, *51*(4). https://doi.org/10. 1080/00219266.2016.1257498

Foronda, C. L., Fernandez-Burgos, M., Nadeau, C., Kelley, C. N., & Henry, M. N. (2020). Virtual Simulation in Nursing Education: A Systematic Review Spanning 1996 to 2018. In *Simulation in Healthcare* (Vol. 15, Issue 1). https://doi.org/10.1097/SIH.0000000000000411

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and Quasi-Experimental Studies of Inquiry-Based Science Teaching: A Meta-Analysis. *Review of Educational Research*, *82*(3). https://doi.org/10.3102/0034654312457206

Garmaise-Yee, J., Houston, C., Johnson, T., & Sarmiento, S. (2022). Virtual simulation debriefing in health professions education: a scoping review protocol. In *JBI Evidence Synthesis* (Vol. 20, Issue 6). https://doi.org/10. 11124/JBIES-21-00170

Khan, R., Scaffidi, M. A., Grover, S. C., Gimpaya, N., & Walsh, C. M. (2019). Simulation in endoscopy: Practical educational strategies to improve learning. *World Journal of Gastrointestinal Endoscopy*, *11*(3). https://doi.org/10.4253/wjge.v11.i3.209

Khan, Z., Rojas, D., Kapralos, B., Grierson, L., & Dubrowski, A. (2018). Using a social, educational network to facilitate peer feedback for a virtual simulation. *Computers in Entertainment*, *16*(2). https://doi.org/10. 1145/3180659

Korgin, A., Ermakov, V., & Kilani, L. Z. (2019). Automation and Processing of Test Data with LabVIEW Software. *IOP Conference Series: Materials Science and Engineering*, *661*(1). https://doi.org/10.1088/1757-899X/661/1/012073

Makransky, G., & Petersen, G. B. (2019). Investigating the learning process with virtual desktop reality: A structural equation modeling approach. *Computers and Education*, *134*. https://doi.org/10.1016/j.compedu.2019.02.002

Cite this article as:
Mokwe, N.C. (2025). Utilizing Simulation to Advance Programming Proficiency Among Computer Engineering Students in Anambra State, Nigeria. *International Journal of Functional Research in Science & Engineering,3*(1), 15-21.

McCoy, L., Lewis, J. H., & Dalton, D. (2016). Gamification and multimedia for medical education: A landscape review. *Journal of the American Osteopathic Association*, *116*(1). https://doi.org/10.7556/jaoa.2016.003

McGarr, O. (2020). Using virtual simulations in teacher education to develop pre-service teachers' behavior and classroom management skills: implications for reflective practice. *Journal of Education for Teaching*, *46*(2). https://doi.org/10.1080/02607476.2020.1724654

Moscato, D. R., & Altschuller, S. (2019). Realizing the potential of virtual world-based simulations in higher education: A visual perspective. *International Journal ofTechnology, Policy, and Management*, *19*(2). https://doi.org/10. 1504/IJTPM.2019.100606

Muchlas, M., & Budiastuti, P. (2020). Development of Learning Devices of Basic Electronic Virtual Laboratory Based on PSPICE Software. *Journal of Vocational Education Studies*, *3*(1). https://doi.org/10. 12928/joves.v3i1.2085

Nassar, H. M., & Tekian, A. (2020). A critical review of computer simulation and virtual reality in undergraduate operative and restorative dental education. In *Journal ofDental Education* (Vol. 84, Issue 7). https://doi.org/10. 1002/jdd.12138

Padilha, J. M., Machado, P. P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: Randomized controlled trial. *Journal ofMedical Internet Research*, *21*(3). https://doi.org/10.2196/11529

Papakonstantinou, M., & Skoumios, M. (2021). Science and engineering practices in the context of Greek, middle school physics textbooks about forces and motion. *Journal ofTechnology and Science Education*, *11*(2). https://doi.org/10.3926/jotse.1286

Perez, A., Gaehle, K., Sobczak, B., & Stein, K. (2022). Virtual Simulation as a Learning Tool for Teaching Graduate Nursing Students to Manage Difficult Conversations. *Clinical Simulation in Nursing*, *62*. https://doi.org/10. 1016/j.ecns.2021.10.003

Qiao, J., Xu, J., Li, L., & Ouyang, Y. Q. (2021). Integrating immersive virtual reality simulation in interprofessional education: A scoping review. In *Nurse Education Today* (Vol. 98). https://doi.org/10.1016/j.nedt.2021.104773

Roy, E., Bakr, M. M., & George, R. (2017). The need for virtual reality simulators in dental education: A review. In *Saudi Dental Journal* (Vol. 29, Issue 2). https://doi.org/10.1016/j.sdentj.2017.02.001

Scahill, E. L., Oliver, N. G., Tallentire, V. R., Edgar, S., & Tiernan, J. F. (2021). An enhanced approach to simulation-based mastery learning: optimizing the educational impact of a novel, National Postgraduate Medical Boot Camp. *Advances in Simulation*, *6*(1). https://doi.org/10.1186/s41077-021-00157-1

Soraya, G. V., Astari, D. E., Natzir, R., Yustisia, I., Kadir, S., Hardjo, M., Nurhadi, A. A., Ulhaq, Z. S., Rasyid, H., & Budu, B. (2022). Benefits and challenges in implementing virtual laboratory simulations (vLABs) for medical biochemistry in Indonesia. *Biochemistry and Molecular Biology Education*, *50*(2). https://doi.org/10. 1002/bmb.21613

Waluyo, B. D., Bintang, S., & Januariyansah, S. (2021). The Effect of Using Proteus Software as A Virtual Laboratory on Student Learning Outcomes. *Paedagoria: Jurnal Kajian, Penelitian Dan Pengembangan Kependidikan*, *12*(1).

Wang, C. Y., Wu, H. K., Lee, S. W. Y., Hwang, F. K., Chang, H. Y., Wu, Y. T., Chiou, G. L., Chen, S., Liang, J. C., Lin, J. W., Lo, H. C., & Tsai, C. C. (2014). A review of research on technology-assisted school science laboratories. *Educational Technology and Society*, *17*(2).

Wertz, C. I. (2022). The impact of virtual radiographic positioning simulation on 1st-year radiography students' clinical preparedness through the lens of activity theory: A mixed method

Cite this article as:
Mokwe, N.C. (2025). Utilizing Simulation to Advance Programming Proficiency Among Computer Engineering Students in Anambra State, Nigeria. *International Journal of Functional Research in Science & Engineering,3*(1), 15-21.

approach. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, *83*(1-B).

Yu, W., & Chen, Z. (2022). Application of VR Virtual Simulation Technology in Teaching and Learning. *Lecture Notes on Data Engineering and Communications Technologies*, *98*. https://doi.org/10.1007/978-3-030-89511-2_43

Zhang, J., & Ma, X. (2022). Application of Computer Virtual Simulation Technology in Landscape Design. *Lecture Notes on Data Engineering and Communications Technologies*, *98*. https://doi.org/10. 1007/978-3-030-89511-2_72

Cite this article as:
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